STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES

FOR

AIR QUALITY MONITORING

APPENDIX W

TECO 42 OXIDES OF NITROGEN ANALYZER

MONITORING AND LABORATORY DIVISION

AUGUST 1994

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TECO 42 OXIDES OF NITROGEN ANALYZER

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APPENDIX W.1

STATION OPERATOR'S PROCEDURES FOR THE TECO 42 OXIDES OF NITROGEN ANALYZER

MONITORING AND LABORATORY DIVISION

TO BE ISSUED

W.1.0 STATION OPERATOR'S PROCEDURES

(TO BE ISSUED)

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AIR QUALITY MONITORING

APPENDIX W.2

ACCEPTANCE TEST PROCEDURE FOR THE TECO 42 OXIDES OF NITROGEN ANALYZER

MONITORING AND LABORATORY DIVISION

AUGUST 1994

W.2.0 PROCEDURE

W.2.0.1 GENERAL INFORMATION - Before beginning acceptance testing of the analyzer, read the manual and ARB purchase specifications thoroughly. Then, initiate an Acceptance Test Log (Figure W.2.0.1) and an Acceptance Test Mini-Report (Figure W.2.0.2). Record the dates of the individual tests, problems, contacts with the manufacturer, and any other pertinent information on the acceptance test log.

W.2.0.2 PHYSICAL INSPECTION - Unpack the analyzer and check for physical damage. Verify that the analyzer is complete and includes all options and parts required by the specifications and purchase order. Remove the top cover from the analyzer and perform the following checks:

1. Make sure that all circuit boards are properly seated in their connectors by removing and reinserting each board.

2. Check for correct power cord phasing; standard wiring configuration has the black wire connected to the brass terminal of the plug, white to the copper terminal, and green to earth ground.

3. Start up the analyzer following the procedures in the manufacturer's manual and verify that all switches and controls operate properly.

4. Leak check the analyzer using appropriate methods for the type of sampling system used.

5. Measure the output of each power supply and record the voltages on the acceptance test mini-report.

W.2.0.3 OPERATIONAL CHECKS - Perform the following operational checks using a strip chart recorder connected to the analog output, and record the results on the acceptance test mini-report. Cut the recorder charts in 24-hour segments and label the bottom of the chart with the following:

Test performed
Date
Make, model number, and serial number of test analyzer
Range on which test is performed
Recorder trace color identification if appropriate

NOTE: Record on the strip chart the numerical values of the trace at the indicated point.

Clear precise notations should be entered on the chart indicating when the tests were started and ended, pertinent information regarding sample flow, gas concentrations, voltages, interferent gases, etc., and any unusual conditions observed. Tests should be run in the range normally used in field operations. All tests should be run in parallel with a control analyzer and recorder whose charts are labeled as above.

1. Diagnostic and Voltage Test - Record all pertinent diagnostics and measured values on the Diagnostic Test form (Figure W.2.0.3). For example:

Diagnostics	Information	Indicated Value
1	Cooler Temp. EC	-3
2	No span factor	0.98

2. Zero and Span Stability - Using a gas calibrator and an appropriate gas standard (super blend), adjust the zero and span controls of the analyzer for proper response. Manually or by using the calibrator timer program, run zero and span points (80 percent). Repeat the zero and span using the same calibrator settings for 30 days. Record the readings of the zero/span drift on the Linearity Zero/Span Drift Tests form (Figure W.2.0.4). Record the changes in zero and span on the Acceptance Test Mini-Report (Figure W.2.0.2).

3. Linearity - Using the automatic gas calibrator remote program, perform a linearity test at 80, 40, 20, 10, 8, 6, 4, and 2 percent of full scale. The predicted response is calculated using the responses of the reference analyzer as illustrated by the following table:

Level	Reference Net % FS Chart	Test Net %FS Chart	Predicted (Calculated)	Non-linearity %FS (Calculated)
80	83.1	82.5	----	----
40	41.6	41.0	41.3	-0.3
20	20.5	20.6	20.4	+0.2
:	:	:	:	:
:	:	:	:	:
2	1.8	1.9	1.9	0.1

For example, the predicted value at the 40 level = $\frac{41.6}{83.1}$ x 82.5 = 41.3

The non-linearity at this level is 41.0 - 41.3 = -0.3 percent

Record the test results on the Linearity Zero/Span Drift Tests form (Figure W.2.0.4), and transfer the non-linearity numbers to the Acceptance Test Mini-report (Figure W.2.0.2). Compare the results to the purchase specifications.

4. Temperature and Voltage Stability - Place the test analyzer in the Thermotron environmental chamber and connect the analyzer power cord to the variable voltage power strip. Connect the sample inlet to the sample manifold supplied by an automatic calibration system. The reference analyzer should remain external to the chamber operating on normal house power. Initiate a temperature/voltage run using Thermotron program number seven (7) while the test and reference analyzer are sampling zero air. Repeat the temperature/voltage run while the analyzers are sampling a concentration equal to 80 percent of full scale. Titrate 50 percent of the NO during the 80 percent of full scale test. Record the test results on the Temperature/Voltage Test form (Figure W.2.0.5). Compare the responses of the test analyzer to the purchase specifications. Transfer the test results to the Acceptance Test Mini-Report (Figure W.2.0.2).

5. Converter Efficiency - Prior to the test, set the converter efficiency to 100 percent on the TECO 42. Following the test, set the converter efficiency to the value determined by the test. Determine the converter efficiency as described in the QA manual Volume II, Section D.2.0.3. The titration step at 500 ppb (NO_2) must be two hours in duration. Use the 0-1000 ppb range and the timer program of the gas calibrator to provide the test concentrations at 0.5 ppm NO_2.

   NOTE: The converter efficiency must be at least 98 percent at the minimum temperature, i.e., for TECO 42, the minimum temperature is 325 $\pm$5EC.

6. Confirm that all recorder charts are properly labeled, the mini-report is complete, and the analyzer meets or exceeds all specifications. Give the test package (mini-report, recorder charts, and log) to your supervisor for review. After the test results have been reviewed and accepted, contact the Administrative Services Division (ASD) property clerk to have a property number assigned and attached to the analyzer, notify the stock clerk that the analyzer completed acceptance testing, complete a move tag, and place the analyzer in the stockroom.

CALIFORNIA AIR RESOURCES BOARD
ACCEPTANCE TEST LOG

Make TECO Model 42

Date	Action

Figure W.2.0.1
Acceptance Test Log

ACCEPTANCE TEST "MINI" REPORT

Make_____ Model_____ Date_____
Serial_____ CARB #_____ Reviewed By_____

		Pass	Fail	Comments
I.	Physical Inspection			
	A. Shipping damage	___	___	_____
	B. Electrical wiring	___	___	_____
	C. Plumbing leaks	___	___	_____
	D. Completeness	___	___	_____
II.	Operational Test			
	A. Control/Indicators	___	___	_____
	B. Diagnostics	___	___	_____
	C. Span/zero	___	___	_____
	D. Programming	___	___	_____
III.	Test Performed	___	___	_____
	A. Zero drift	___	___	_____
	B. Span drift	___	___	_____
	C. Linearity	___	___	_____
	D. Temperature (zero/span)	___	___	_____
	E. Voltage (zero/span)	___	___	_____
IV.	Converter Efficiency	___	___	_____
IV.	Maintenance Performed	___	___	_____

Average Diff. True-Ind. Must be less than 1% of Full Scale (.01V)

Linear Regression Slope_____ Intercept_____ Correlation_____
*Attach charts and forms

Figure W.2.0.2
Acceptance Test "Mini" Report

CALIFORNIA AIR RESOURCES BOARD
DIAGNOSTIC RECORD

Make TECO Model 42
SN Test Date

Diagnostics	Information	Indicated Value	
c1	cooler temp		
ct	converter temp		
rc	rx chamber temp		
bl	NO zero backgrnd		
b3	NO_x zero backgrnd		
S.F.	NO span factor		
b.f.	NO_x balance factor		
ce	converter efficiency		
nr	thumbwheel reading		
0	analog offset		
dip	dip switch status		
	press/temp		
	temp on/off		
	temp		

Flow:
Ozone
Sample
Vacuum Averaging

Figure W.2.0.3
Diagnostic Test

CALIFORNIA AIR RESOURCES BOARD

Make TECO Model 42
SN Test Date

LINEARITY TEST

Reference			Test			
Level	Gross %FS	Net %FS	Gross %FS	Net %FS	Predicted (Calculated)	Non-linearity
0						
80						
40						
20						
10						
5						
2						

ZERO/SPAN DRIFT

	Zero		Span	
	%FS	%FS Dev	%FS	%FS Dev
Initial				
30 Day				

Figure W.2.0.4
Linearity Zero/Span Drift Tests

CALIFORNIA AIR RESOURCES BOARD
TEMPERATURE/VOLTAGE TEST

Make TECO Model 42
SN Test Date

TempEC	Voltage	Reference	Test	%FS
25	115			
35	115			
35	125			
35	105			
44	115			
25	115			
15	115			
15	125			
15	105			
4	115			
25	115			

Figure W.2.0.5
Temperature/Voltage Test

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FOR

AIR QUALITY MONITORING

APPENDIX W.3

CALIBRATION PROCEDURE

FOR

TECO 42 NITROGEN OXIDES ANALYZER

MONITORING AND LABORATORY DIVISION

FEBRUARY 2000

W.3.0 CALIBRATION PROCEDURE

W.3.0.1 INTRODUCTION

This calibration procedure employs a set of NIST traceable, certified mass flow controllers which dilute a NIST traceable, certified nitric oxide (NO) gas mixture with zero grade air. The gas dilution system, with these gases, is operated to produce a multi-point "as is", and, if necessary, a multi-point "final" calibration. This document describes the procedure using portable, certified mass flow meters, a blended gas cylinder, and a certified ozone photometer. The same procedures may be followed at ARB sites with a certified NIST 9100 Environics calibrator; the 9100 serves as the transfer standard.

The NOx analyzer is calibrated when known concentrations of NO and NOx are entered into the analyzer until readings stabilize. The calculated gas quantity from the calibration system is entered on the NOx analyzer's input thumbhole. The "STAT" button is pushed until the display shows the level of the gas being calibrated. When the "CAL" button is pushed followed by "ENTER", the appropriate NO or NOx channel is calibrated. The "ENTER" button must also be pushed while the display reads "STORE" to save the calibration value in the event that there is a power failure.

W.3.0.2 APPARATUS

NIST traceable nitric oxide gas mixture (@50 ppm)
Gas calibration system
Set of certified 4-in-1 mass flow meters (MFMs)
Calculator capable of linear regression
Calibration forms (MLD 47A) or Computer Forms (Quattro Pro or Excel Spreadsheets)
Tool kit
Data logger and a chart recorder
Clean Air Package or Aadco Air Purifier
Stainless Steel gas regulator, CGA 660.
Timer/stopwatch

All connections between components in the calibration system should be made of glass, Teflon, or other non-reactive materials.

W.3.0.3 INSTRUMENT CALIBRATION

1. Initial Setup - This procedure follows the calibration guidelines in Section 3 (page III-2) and Section 4 (pages IV-1 through IV-14) of the ThermoEnvironmental (TECO) 42 manual.

a. Plug in the (MFMs) flow transfer standards. They should warm up for at least one hour.

b. Plug in the Calibrator and turn on the power switch. Let the instrument warm up for at least one hour. Place the stainless 660 CGA regulator on the NO cylinder.

c. Purge the calibration gas through the regulator three times before use. This will reduce NO2 contamination. Connect the Dasibi gas calibration system to the TECO 42 and the gas standard. Place the output tubing of the gas calibration system onto the inlet of the NO in-line particulate filter. Place a cap on the NO glass manifold inlet.

2. Calibration System Connection

a. Connect zero air to the calibration system and adjust the air pressure to the manufacturer's specifications.

b. Purge the gas calibration system with zero air at a flow rate of 5 liters per minute while the gas calibration system warms up.

3. Data Recording Preparation

a. Disable the data logger for the NOx, NO, and NO2 channels.

b. Prepare all the headings and other information on the hardcopy calibration forms (Ref. Figure W.3.0.1-3) or alternately, on the laptop computer spreadsheet form (Ref. Figure W.3.0.2, Quattro Pro or Excel).

4. Analyzer Flow Checks- Other than routine daily checks, analyzer repairs or adjustments should not be made prior to the "as is" calibration.

a. With the 4-in-1 flow transfer standard, check the TECO 42's flows. Disconnect the 1/4 Swagelock connection for the ozone flow. (If the dry air flow is not available from the rear of the instrument, the flow should be plumbed to make this possible.) This port is labeled "Dry Air" in the back of the instrument.

b. Connect this port to the 1-liter or 3-liter flow standard. Record the flow standard's display. Determine the flow by using the certification equation for this flow standard. The ARB units were modified to a

nominal flow of 200± 50 cc/minute.

c. Record the rotameter flow from the front of the instrument. Reconnect the filter after the flow check is complete.

d. Check the rate of the analyzer's "Sample" flow. Disconnect the 1/4 Swagelock connection for the sample flow. This port is labeled "Sample" in the back of the instrument. Connect this port to the 1-liter or 3-liter flow standard. Record the MFM's display. Determine the standard flow by using the certification equation for the flow standard. The nominal flow of this port is 700 cc/minute.

e. Record the rotameter's flow from the front of the instrument. Reconnect the sample inlet line after the flow check is complete.

W.3.0.4 AS IS CALIBRATION

1. Initial Checks

a. Before performing an "as-is" calibration, ensure that the particulate filter on the sample inlet line has been recently changed. If not, replace it. Verify the analyzer has recently been electronically Zero and Span checked on all three channels.

b. Adjust, if necessary, to ensure the analyzer’s output is properly aligned.

2. Zero Calibration Checks

a Allow the gas dilution system to operate for at least 30 minutes with zero air flowing at 5-6 LPM.

b. A timer/stopwatch can be used to meter the time between calibration steps.

c. Read and record the zero readings from the NO and NOx channels of the data logger.

3. Span Calibration Checks

a. At the discretion of the person performing the instrument calibration, one of two procedures may be used. The selection of the appropriate procedure depends on the analyzer response to the first point test span gas.

b. Run one (1) “as-is” calibration point at approximately 80 percent of the upper range limit (URL). Allow sufficient time for the analyzer response to stabilize. If the analyzer response is within ±10 percent of true and meets requirements of Table W.3.0.1, do the following: Record the “as-is” results on the “as-is” calibration form. Indicate on the bottom of the raw datasheet that the response was within 10 percent of true for the initial 80 percent level. After the response of this first point has been recorded, the person doing calibration may select one of the following procedures: c or d.

c. If the analyzer is operating normally, previous nightly spans indicate no abnormality, and there are no other indications of malfunctions, the analyzer may be re-spanned to reflect the true gas concentration. To make a span adjustment, follow the instructions found in Section W.3.0.6, items 3 and 4.

d. As an alternative, a multi-point “as-is” calibration may be completed for the following steps 4a through f.

4. Complete “As-Is” Calibration - Perform the instrument “as-is” linearity calibration by completing a multi-point calibration.

a. Run four (4) "as is" calibration points. Determine the calibration set points by the following formula:

$$\text{NO ppm} = \frac{G \times C}{G + A}$$

where: G = the flow of gas in cc/m, A = the flow of air in cc/m and, C = the concentration, in ppm, of the NO gas standard

b. These calibration points should be approximately 80 percent, 40 percent, 20 percent, and 10 percent of the upper range limit (URL). For example, if the full-scale output of the NO/NOx analyzer is 1.0 ppm, 80 percent of the URL equals 0.80 ppm NO.

c. Calculate the true NO and NOx values from the cylinder and flow transfer standard certification numbers. Record on the datasheet.

Read and record the instrument's output for the 80 percent URL level, after 20 minutes or a stable reading is indicated on the chart recorder. Repeat this process for the 40 percent, 20 percent, 10 percent, and zero levels on the datasheet.

d. Calculate the slope and intercepts for the NO and NOx data with the linear regression equation.

e. Determine the "as is change from previous calibration" for the NO and NOx channels.

f. Mark the strip chart recorders with the type of calibration, date and calibrator's name. In addition, record the NO/NO2/NOx calibration in the station's logbook.

W.3.0.5 CONVERTER EFFICIENCY

1. Converter Efficiency Determination - Read and record the converter efficiency (C.E.) from the previous calibration. This information can be obtained by pressing the "STAT" button until "C.E. XX.X" is displayed.

   a. Perform the converter efficiency test with a value of 100.0 in the "C.E. XX.X" display. To determine the TECO 42's converter efficiency, operate the gas calibration system near .70 ppm NO. The test will be conducted with the same plumbing configuration as in the "as is" calibration; however, one of the dilution system manifold output ports will be connected to the ozone analyzer's input port. Monitor the ozone concentration during the Gas Phase Titration (GPT) to ensure that all of the ozone is consumed in the reaction. The ozone concentration must be less than 90 percent of the NO concentration. Refer to CFR 40, Part 50, Appendix F, for a detailed explanation of the theory behind gas phase titration.

   b. An alternate plumbing configuration is also acceptable. This configuration does not use a connection of the ozone photometer to the calibrator manifold. The alternate configuration can be used if prior experience has shown more than 10 percent of the NO concentration remains after the complete titration of the available ozone is stable. If prior experience with the calibrator shows all ozone being consumed

during the titration and at least 10 percent NO is left, then note the set points for the mass flow controllers and the ozone generator that produced the desirable test points.

c. Follow the steps starting at Section 3.0.5, item 2, for the alternate plumbing configuration, bypassing steps referring to the ozone photometer, (the following steps have been extracted from the Dasibi 5009 Gas Dilution System Manual).

2. Alternate Converter Efficiency Method

a. Set the gas MFC to deliver a NO concentration between 0.60 and 0.80 ppm.

b. Set the airflow rate to 4-6 LPM.

c. Connect one of the Dasibi 5009 dilution system exit ports to the inlet port of the ozone photometer.

d. Operate the 5009 in the "Auto" and "Load" modes. (Refer to the Dasibi 5009CP manual for detailed operating procedures).

e Turn on the 5009 photometer pump, and adjust the flow rate through the photometer to 1.5 to 2.0 LPM flow rate. Set the Dasibi 5009 thumb wheel Diagnostic switch to “0”.

f. Allow the TECO 42 to sample until the NO/NOX response is stable for 15 to 20 minutes. Record the NO and NOx readings from the data logger onto page 2 of Figure 3.0.1, (form MLD-47), or onto Figure 3.0.3 (computer worksheet).

g. Press "Gas Vent" on the 5009 to open the gas vent.

h. Adjust the ozone level control switch to produce an ozone concentration that is approximately 80 percent of the NO concentration and press the “OZONE” button. This ozone setting will result in a nitrogen dioxide concentration near 0.50 ppm. Set Timer for 15 minutes to allow the ozone reading to stabilize.

i. Set the Latch/Load (L/L) switch to "Latch"

j. Press "Gas Vent" (to close vent)

k Set timer, wait 15 minutes, and record readings from the data-logger on the converter efficiency form (Figure W.3.0.1, MLD-47, page 2 of 3) or on the computer worksheet (Figure W.3.0.3).

NOTE: During GPT, observe the reaction results by monitoring the analyzer NO response at the data logger. Ensure that at least 10 percent of the original NO is left to eliminate destruction of the molybdenum converter by ozone. Allow titration to continue until the analyzer response is stable.

l. Push the “OZONE” button to turn ozone production off and allow NO concentration to return to the pre-titration level.

m. Repeat the steps above until GPTs have been completed for more computer efficiency steps if needed. It is suggested that 0.35, 0.25, and 0.90 ppm nitrogen dioxide concentrations be used for the remaining gas phase titration levels.

n. After completion of the GPT testing and after the readings are recorded, the "ozone" switch should be turned off, the ozone thumb wheel is set to "000", and the "Man/Auto" switch is placed in the "manual" position. Leaving the ozone on unnecessarily will decrease the lifetime of the generator's drive board and the U. V. lamp.

o. After all of the readings have been taken, calculate the analyzer's "Average Percent Converter Efficiency". First, calculate the converter efficiency for each point by the following equation:

$$\text{C. E.} = \frac{(\text{Delta NO} - \text{Delta NOx}) \times 100}{(\text{Delta NO})}$$

p. Calculate the average converter efficiency. This is achieved by summing the converter efficiencies for each point, then dividing this result by the number of converter efficiency points. If the converter efficiency is less than 96 percent, a corrective action must be taken. For a detailed description of the GPT theory, see Appendix D, Volume II.

q. Converter efficiency (CE) will be set at 100 percent in the STAT mode. To set the converter efficiency to 100 percent, press the STAT

button repeatedly until "CE" scrolls onto the screen. Dial the CE value in the thumb wheel at the bottom of the front panel, (i.e., 100.0% = 1000). Press ENTER.

W.3.0.6 ZERO AND SPAN CORRECTION

1. Adjustments for Final Calibration - If the TECO 42 has been calibrated previously at this location, and the "as is" calibration is within five percent of "true", and if adjustments have not been made to the analyzer, the "as is" calibration can be used as a "final" calibration. If the instrument is outside of these parameters, it must be set to zero and spanned before a final calibration can be performed (Table W.3.0.2 troubleshooting guide may be used as a reference for certain conditions to determine a possible malfunction).

2. Instrument Zero - The instrument must be in the "AUTO" mode. Run zero air, from the clean air package or Aadco air purifier, through the gas calibration system for approximately 30 minutes or until a stable reading is achieved for 5 minutes. Press the "DISPLAY" button until "1" appears in the leftmost LED display. (1 is the NO channel). Press the Cal button. Enter “0000" on the thumb wheel. Press "ENTER". Repeat this procedure for the NOx channel (3 is the NOx channel).

3. NO Span - Set the Dasibi 1009 or 5009 to approximately 80 percent of the Upper Range Limit (URL) (0.8 ppm)

    a. Challenge the instrument with this level of gas for 30 minutes or until a steady trace is achieved for at least 5 minutes. The instrument must operate in the "AUTO" mode for at least 300 seconds with a stable reading. Observe the data logger value. Enter the calculated value for the NO concentration on the thumb wheel (4 position set pot). The calculated NO value is based on the NO assay value, the gas calibrator's gas certification value, and the gas calibrator's air certification value. For example, a value of .8 ppm will be entered as "0800" on the thumb wheel switch. Press the "CAL" button. The light above the CAL button will illuminate. Press the "DISPLAY" button until the leftmost LED display reads 1, (1=NO, 2=NO2, 3=NOx). Press "ENTER" and the NO channel set point will be reset to the calculated value for NO. Since the NO/NOx calibration values tend to drift downward as time increases, it is desirable to set the thumb wheel setting @ 2 percent higher than the calculated dilution values., (e.g., If the concentration of NO has been calculated to be 0.782 ppm NO, set the thumb wheel setting to .798 ppm NO.)

4. NOx Span

a. Press the "DISPLAY" button until the number “3" appears in the leftmost LED display. The instrument must operate in the "AUTO" mode for at least 300 seconds with a stable reading. Press the "CAL" button. Observe the data logger value. Enter the NOx concentration into the thumb wheel switch. Press "ENTER" and the NOx channel set point will be reset to the calculated value for NOx.

W.3.0.7 FINAL CALIBRATION

1. Final Calibration Procedure - If the instrument has been re-zeroed, re-spanned, had its converter efficiency changed by greater that 1.0 percent, or a major maintenance operation performed, a "final" calibration must be performed. Fill out the final calibration form or laptop computer form, as much as possible, then begin the actual calibration. Since the basic principle of operation of this sampler is the subtraction of NO from NOx, it is not deemed necessary to calibrate the NO2 channel. The final calibration steps are the same as the “as-is”, but are briefly summarized below.

a. Send zero air to the instrument through the gas dilution system. Record zero readings after 20 minutes of zero air or 5 minutes of stable zero readings. Run four (4) final calibration points using the gas calibration system. These points should be at 80 percent, 40 percent, 20 percent, and 10 percent of the URL. Calculate the true NO and NOx values from the cylinder and flow transfer standard certification numbers. Record this data on the datasheet. Read and record the instrument's output, from the data logger, for the 80 percent, 40 percent, 20 percent, and 10 percent levels.

b. Sum the net NOx concentrations and record the data on the datasheet. Sum the net NO and NOx data logger readings (DAS). Calculate the "Percent Deviation from true”, for NO and NOx. Record on the datasheet. Calculate the linear regressions for NO and NOx. With the results from the previous calibration report, calculate the "As-is change from previous calibration” for the NO and NOx data. Record these percentages on the datasheet. Note any worthy comments at the bottom of the datasheet.

W.3.0.8 COMPLETION OF CALIBRATION STEPS

1. Enable all appropriate data logger channels.

2. If the station zero air system is used, reconnect the zero air supply, and set the pressure regulator to its pre-calibration setting.

3. Close valve and turn off compressed gas calibration cylinder.

4. Have the station technician initiate the nightly calibration dilution system, and verify that the data produced is within acceptable limits.

5. Plot the results of the calibration using an acceptable spreadsheet program. The “indicated” data logger readings are on the y axis. The “true” NO/NOx concentrations will be plotted on the x axis.

NO/NO2/NOx CHEMILUMINESCENT ANALYZER
CALIBRATION DATASHEET

Site Name: _____ Calibration: As Is [ ] Final [ ]
Site Number: _____ Date: _____ Log Number: _____
Site Temperature: _____ Barometric Pressure: _____ Site Elevation: _____

ANALYZER IDENTIFICATION

Make and Model _____ Property No. _____ Serial No. _____
Span Settings: NO _____ NO2 _____ NOx _____ Zero Settings: NO _____ NO2 _____ NOx _____
Rx Chamber Vacuum _____ Converter Temperature _____ Range NO _____ NO2 _____ NOx _____
Ozone Flow: ΔP _____ Flow _____ sccm @ _____ Flow Setting. Flow measurement device:
Sample Flow (NO): ΔP _____ Flow _____ sccm @ _____ Flow Setting. Type _____
(NOx): ΔP _____ Flow _____ sccm @ _____ Flow Setting. Prop. No. _____
Elec Span (OPER): NO _____ NO2 _____ NOx _____ Electronic Zero: NO _____ NO2 _____ NOx _____
Elec Span (TEST): NO _____ NO2 _____ NOx _____ Unsupp. Dark Current _____ ppb (limit 40 ppb)
Additional Information _____

TRANSFER STANDARD IDENTIFICATION

Make and Model _____ Property No. _____ Serial No. _____
Certification Date _____ Certification Expires _____
Certification Equations: Air Flow = Display x _____ ± _____, SLPM
Gas Flow = Display x _____ ± _____, SCCM
Zero Air Source _____ Property No. _____ Serial No. _____
NO Compressed Gas Cylinder No. _____ Cylinder Pressure _____
Certification Date _____ Certification Expires _____
Certified Concentration _____ ppm NO; _____ ppm NOx
Additional Information _____

CONVERTER EFFICIENCY DETERMINATION

Ozone Set Pt	Ozone Off NO (1)	Ozone Off NO2	Ozone Off NOx (3)	Ozone On NO (2)	Ozone On NO2	Ozone On NOx (4)	ΔNO (1)-(2)	ΔNOx (3)-(4)	Converter Efficiency (ΔNO - ΔNOx)/ΔNO

Average Converter Efficiency _____

Comments _____

MLD-47 (11/89) Calibrated By _____ Checked By _____

Figure W.3.0.1
Calibration Datasheet

NO/NO2/NOx CHEMILUMINESCENT ANALYZER
CALIBRATION DATASHEET

Site Name: _____ Calibration: As Is [ ] Final [ ]
Site Number: _____ Date: _____ Log Number: _____

PRIMARY DATA ACQUISITION SYSTEM (DAS) IDENTIFICATION

Make & Model _____ Prop. No. _____ Serial No. _____
Additional Information: _____

NITRIC OXIDE CALIBRATION

Zero Settings: NO ____ NO2 ____ NOx ____ ; Span Settings: NO ____ NO2 ____ NOx ____

Transfer Standard					[NO]	[NOx]	NO			NOx		
NO Gas Flow Display	NO Gas Flow sccm	Dilution Flow Display	Dilution Flow sccm	Total Flow sccm	OUT (ppm)	OUT (ppm)	Chart (% FS)	DAS (ppm)	Net DAS	Chart (% FS)	DAS (ppm)	Net DAS
				Σ	Σ			Σ			Σ	

Percent Deviation from True:

NO: $\left(\frac{\Sigma \text{ NO Net DAS}}{\Sigma\ [NO]_{OUT}} - 1 \right) \times 100\% =$ _____ %

NOx: $\left(\frac{\Sigma \text{ NOx Net DAS}}{\Sigma\ [NOx]_{OUT}} - 1 \right) \times 100\% =$ _____ %

Linear Regression: Analyzer Response (ppm), NO, = $\left(\frac{\quad}{\text{Slope}}\right) ([NO]_{OUT}) \pm \left(\frac{\quad}{\text{Intercept}}\right)$ ppm

Analyzer Response (ppm), NOx, = $\left(\frac{\quad}{\text{Slope}}\right) ([NOx]_{OUT}) \pm \left(\frac{\quad}{\text{Intercept}}\right)$

As Is Change From Previous Calibration Dated _____:

NO: $\left(\frac{\text{As Is Slope - Old Slope}}{\text{Old Slope}}\right) \times 100\% = (\quad) \times 100\% =$ _____ %

NOx: $\left(\frac{\text{As Is Slope - Old Slope}}{\text{Old Slope}}\right) \times 100\% = (\quad) \times 100\% =$ _____ %

Comments: _____

MLD-47 (11/89) Calibrated By _____ Checked By _____

Figure W.3.0.1
Calibration Datasheet (cont.)

STATS TABLE FOR CALIBRATION

Site Name:_____ Calibration: As Is |__| Final |__|
'ite Number:_____ Date:_____ Log Number:_____

///DIAG/STATUS///	///INFORMATION////	////////
1 F.SCALE	Full Scale ppb	
2 F.SCALE	Full Scale ppb	
3 F.SCALE	Full Scale ppb	
	Integrtn Time secs	
trb	Troubleshoot on/off	
c1	Cooler Temp °C	
ct	Converter Temp°C	
rc	RX Chamber Temp°C	
b1	NO Zero Backgrd	
b3	NOx Zero Backgrd	
S.F.	NO Span Factor	
b.f.	NOx Balance Fctr	
ce	Convert Effic'y %	
0	Analog Offset	
d IP	DIP Switch Status	
1 to 8	Dip Swtchs 1,2,3	
P	Program Number	
t	P/T on/off	
oC	Internal Temp.	

Figure W.3.0.1
Calibration Datasheet (cont.)

ARB Calibration Report -- TECO 42 NO, NO2, NOx Analyzer

Calibration Report:

ID Information:

Station Name:	Roseville
Site #:	31-822
Station Address:	151 No. Sunrise
Agency:	ARB

Instrument:

Make:	TECO
Model #:	42
Property #:	20003395
Serial #:	42-47558-279
Log #:	N/A

Calibration:

"As Is"	X
"Final"	
Calib. Date	1/24/97
Report Date	
Prev. Calib. Date	6/28/96

Calibration Results:

Pollutant:		NO	NO2	NOx
Instrument Range, ppm:		0-1.0	0-1.0	0-1.0
Previous Slope:		1.0177		1.0219
Converter Efficiency (Avg.):			100.0%	
	Slope:	1.0332		1.0332
Best Fit Line	Intercept:	-0.0051		-0.0051
	Correlation:	0.9998		0.9998
"As Is" Deviation from True:		2.0%		2.0%

Meteorology:

Temp. (Deg. C):	25.0
Atm. Pres. (mm Hg)	762.0
Elevation (Ft.):	150

Data Aquisition System (DAS):

Make:	ESC
Model #:	8800
Property #:	20002495

Instrument Parameters:

Pollutant:	Ozone:	NO & NOx:
MFC Display:	0.72	
Flow Rate (slpm):	0.707	-0.078
Flow Setting:	0.30	1.8
Delta Pres.:	N/A	N/A
Rx Cham. Vac. (in Hg):	22.0	
Converter Temp. (C):	320	
Conv. Temp. Setting (C):	325	

Compressed Gas Cylinder:

Make & Model:	Super Blnd.
I.D. #:	JJ8743
NO Conc. (ppm):	52.1
NOx Conc. (ppm):	52.1
Cylinder Pres. (psi):	1750
Outlet. Pres. (psi):	16
Cert. Date:	11/6/95
Cert. Exp.:	11/1/96

Dilution Transfer Standard I.D.:

Make & Model:	Dasibi 5009-CP	Gas T. (C):	36.6
Property No.:	20003997	Air Flow (v):	2.50
Serial No.:		Gas Flow (v):	0.0
Air Flow Setting:	5.0	P/T (on/off):	On
Air Flow Rate (Display):	5.00	Cert. Date:	12/9/96
Gas Pres. (mmHg):	762	Cert. Exp.:	3/9/97

Dilution Air:

Make & Model:	S.RIDER
Property No.:	N/A
O-let Pres. (psi):	14

Transfer Standard Equation:

		m:	x:		b:	
Dasibi 5009 Gas:	Gas Flow =	1.0159	* Avg. Disp.	+/-	0.4497	SCCM
Dasibi 5009 Air:	Air Flow =	0.9654	* Avg. Disp.	+/-	0.1437	SCCM
MFC 0-30 lpm:	Air Flow =		* Avg. Disp.	+/-		SLPM
MFC 0-3 lpm:	Air Flow =	1.0889	* Avg. Disp.	+/-	-0.0784	SLPM

Calibration Data:

Gas Dilution (Transfer Standard):

NO Gas Setting:	NO Gas Flow Display:	SCCM:	Dilution Flow Display:	SCCM:	Total Flow SCCM:
0	0.0	0.000	5.00	4970.7	4970.7
75	74.8	76.44	5.00	4970.7	5047.1
35	34.7	35.70	5.00	4970.7	5006.4
20	20.6	21.34	5.00	4970.7	4992.0
10	10.4	11.03	5.00	4970.7	4981.7
0	0.0	0.000	5.00	4970.7	4970.7

Figure W.3.0.2
NO/NOX Calibration Report (Computer Form)

ARB Calibration Report -- TECO 42 NO, NO2, NOx Analyzer

NO Calibration Data (Instrument):

NO Out (x) ppm:	Chart % Full Scale	DAS ppm	Net DAS (y) ppm	Graph Values
0.000	0.0%	0.000		-0.005
0.789	80.8%	0.807	0.807	0.810
0.372	38.9%	0.388	0.388	0.379
0.223	22.3%	0.223	0.223	0.225
0.115	11.1%	0.110	0.110	0.114
0.000	0.0%	0.000		-0.005
1.499			1.528	

Linear Regression Equ.:

Net DAS=NO (out) * x+b (ppm)	
x :	1.0332
b :	-0.0051

Percent Deviation from True:

NO Net DAS vs. NO Out:	2.0%

NOx Calibration Data (Instrument):

NOx Out (x) ppm:	Chart % Full Scale	DAS ppm	Net DAS (y) ppm	Graph Values
0.000	0.0%	0.000		-0.005
0.789	80.8%	0.807	0.807	0.810
0.372	38.9%	0.388	0.388	0.379
0.223	22.3%	0.223	0.223	0.225
0.115	11.1%	0.110	0.110	0.114
0.000	0.0%	0.000		-0.005
1.499			1.528	

Linear Regression Equ.:

Net DAS=NOx (out)* x+b (ppm)	
x :	1.0332
b :	-0.0051

Percent Deviation from True:

NOx Net DAS vs. NOx Out:	2.0%

NO vs. Net DAS Linear Regression Output:

Constant		-0.00510
Std Err of Y Est		0.00759
R Squared		0.99959
No. of Observations		4
Degrees of Freedom		2
Correlation	0.99979	
X Coefficient(s)	1.0332	
Std Err of Coef.	0.0148	

Slope % dif. As Is vs. Prev. Cal.:

NO:	1.53%
NOx:	1.11%

NOx vs. Net DAS Linear Regression Output:

Constant		-0.00510
Std Err of Y Est		0.00759
R Squared		0.99959
No. of Observations		4
Degrees of Freedom		2
Correlation	0.99979	
X Coefficient(s)	1.0332	
Std Err of Coef.	0.0148	

Comments:			
Calibrated by:	J. Crumpler	Checked by:	

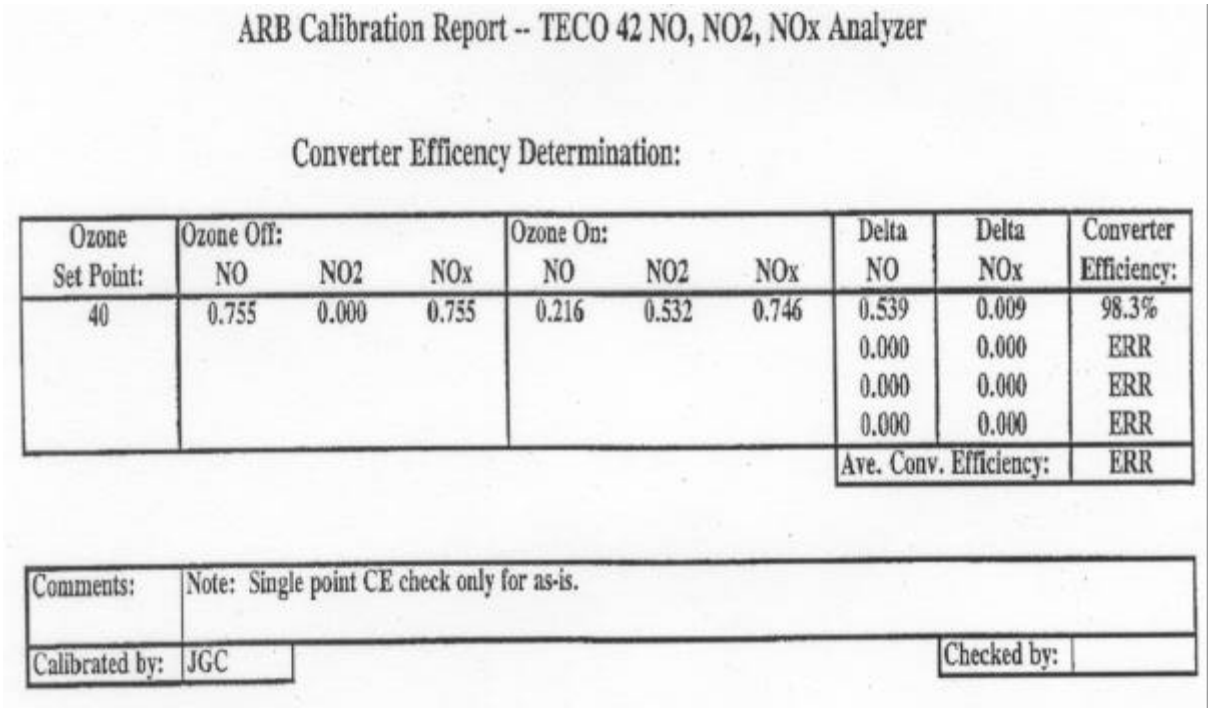
Figure W.3.0.2
NO/NOX Calibration Report (cont.)

ARB Calibration Report -- TECO 42 NO, NO2, NOx Analyzer

Make:	TECO		Model:	42
Serial #:	See cover sheet		Date:	1/24/97

Diagnostics:	Description:	"As Is" Value:	"Final" Value:	Range:
	Full Scale	1000 ppb	1000 ppb	0 - 1000 ppb
	NO	1000	1000	0 - 1000 ppb
	NO2	1000	1000	0 - 1000 ppb
	NOx	1000	1000	0 - 1000 ppb
	Time Avg. Setting	300 sec.		300 sec.
	Trouble-shoot	On		On/Off
cl.	Cooler Temp.	3.3		-3 C +/- 1C
ct.	Converter Temp.	320		325 C +/- 25C
r.c.	Reaction Chamber Temp.	49.5		50 C +/- 1C
b1	NO Zero Background	0.3		2.9 to 3.5
b3	NOx Zero Background	1.5		3.2 to 3.6
S.F.	NO Span Factor	1.005		1.0 to 3.999
b.F.	NOx Balance Factor	0.996		.96 to 1.04
ce	NO2 Converter Efficiency	100.0		96.0 to 100%
nr	Thumbwheel Reading	Thumbwheel	Thumbwheel	Thumbwheel
0	Analog Offset %	0		0
dip	DIP Switch Status			
	DIP #1 to #8 Display			
	Program Number	4258		
	P/T	On		On/Off
	Internal Temperature	34.9		Ambient + 5 C
	Sample Pressure			
	Input Board Offset			

Figure W.3.0.2
NO/NOX Calibration Report (cont.)



ARB Calibration Report -- TECO 42 NO, NO2, NOx Analyzer

Converter Efficency Determination:

Ozone Set Point:	Ozone Off: NO	NO2	NOx	Ozone On: NO	NO2	NOx	Delta NO	Delta NOx	Converter Efficiency:
40	0.755	0.000	0.755	0.216	0.532	0.746	0.539	0.009	98.3%
							0.000	0.000	ERR
							0.000	0.000	ERR
							0.000	0.000	ERR
							Ave. Conv. Efficiency:		ERR

Comments:	Note: Single point CE check only for as-is.		
Calibrated by:	JGC	Checked by:	

Figure W.3.0.3
NO/NOX Converter Efficiency (Computer Form)

Table W.3.0.1
"As Is" Calibration Tolerances

Item	Parameter	Tolerances
Converter Efficiency	100 %	> 96 %
Converter Temperature	325EC	+/- 25 EC
Zero Value	True Zero	+/- 0.5 Divisions
NO/NOX Value	True Value	+/- 5 %
NO/NOX Output	Spread Between Values	+/- 2 Divisions
Sample Flow	700 cc/min	+/- 100 cc/min
Ozone Flow	225 cc/min	+/- 25 cc/min
System Vacuum	23 in Hg	> 22 in Hg

Table W.3.0.2
Analyzer Troubleshooting Guide

NO2/O3 Ratio	O3 Reading	NO2 Reading	Probable Cause
constant	decreasing	decreasing	Cal UV lamp output decreasing
increasing	decreasing	constant	O3 analyzer needs calibration
increasing	constant	increasing	NO/NOX analyzer needs calibration
decreasing	constant	decreasing	bad NO2 converter or NO/NOX analyzer needs calibration
decreasing	increasing	constant	malfunctioning ozone analyzer